

WE CLAIM:

1. A method of determining and displaying risk information in response to a plurality of  
5 input data, comprising the steps of:

receiving said plurality of input data, said input data including a plurality of input data  
calculation results;

- 10 comparing each calculation result of said plurality of input data calculation results with  
each logical expression of a plurality of logical expressions, ranking by said logical  
expression said calculation result, and generating a plurality of ranked risk values in  
response thereto, each of said plurality of ranked risk values representing an input data  
calculation result that has been ranked by said logical expression as either a high risk or a  
15 medium risk or a low risk;

generating said risk information in response to said plurality of ranked risk values; and

displaying said risk information.

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2. The method of claim 1, wherein said risk information comprises a one or more ranked  
risk categories.

3. The method of claim 1, wherein said risk information comprises one or more ranked  
25 subcategory risks.

4. The method of claim 1, wherein said risk information comprises a plurality of ranked  
individual risks.

- 30 5. The method of claim 2, wherein said risk categories are selected from a group  
consisting of: an average individual risk, a subcategory risk, an average subcategory risk,

a total risk, an average total risk, a potential risk for each design task, and an actual risk for each design task.

6. The method of claim 5, wherein said subcategory risks of said risk categories is  
5 selected from a group consisting of: gains risks, losses risks, stuck pipe risks, and mechanical risks.

7. The method of claim 4, wherein said individual risks are selected from a group  
consisting of: H2S and CO2, Hydrates, Well water depth, Tortuosity, Dogleg severity,  
10 Directional Drilling Index, Inclination, Horizontal displacement, Casing Wear, High pore pressure, Low pore pressure, Hard rock, Soft Rock, High temperature, Water-depth to rig rating, Well depth to rig rating, mud weight to kick, mud weight to losses, mud weight to fracture, mud weight window, Wellbore stability window, wellbore stability, Hole section length, Casing design factor, Hole to casing clearance, casing to casing clearance, casing  
15 to bit clearance, casing linear weight, Casing maximum overpull, Low top of cement, Cement to kick, cement to losses, cement to fracture, Bit excess work, Bit work, Bit footage, bit hours, Bit revolutions, Bit Rate of Penetration, Drillstring maximum overpull, Bit compressive strength, Kick tolerance, Critical flow rate, Maximum flow rate, Small nozzle area, Standpipe pressure, ECD to fracture, ECD to losses, Gains, Gains Average,  
20 Losses, Losses average, Stuck, Stuck average, Mechanical, Mechanical average, Risk Average, Subsea BOP, Large Hole, Small Hole, Number of casing strings, Drillstring parting, and Cuttings.

8. The method of claim 2, wherein the step of generating said risk information in  
25 response to said plurality of ranked risk values comprises the steps of:

receiving said plurality of ranked risk values and calculating said one or more ranked risk categories.

9. The method of claim 8, wherein the step of displaying said risk information comprises the step of: displaying said one or more ranked risk categories.

10. The method of claim 3, wherein the step of generating said risk information in  
5 response to said plurality of ranked risk values comprises the steps of:

receiving said plurality of ranked risk values and calculating said one or more ranked subcategory risks.

10 11. The method of claim 10, wherein the step of displaying said risk information comprises the step of: displaying said one or more ranked subcategory risks.

12. The method of claim 4, wherein the step of generating said risk information in response to said plurality of ranked risk values comprises the steps of:

15 receiving said plurality of ranked risk values and using said plurality of ranked risk values to represent said plurality of ranked individual risks.

13. The method of claim 12, wherein the step of displaying said risk information  
20 comprises the step of: displaying said plurality of ranked individual risks.

14. The method of claim 2, wherein said risk information comprises one or more ranked subcategory risks.

25 15. The method of claim 14, wherein said risk information comprises a plurality of ranked individual risks.

16. The method of claim 15, wherein said risk categories are selected from a group consisting of: an average individual risk, a subcategory risk, an average subcategory risk,

a total risk, an average total risk, a potential risk for each design task, and an actual risk for each design task.

17. The method of claim 16, wherein said subcategory risks of said risk categories is  
5 selected from a group consisting of: gains risks, losses risks, stuck pipe risks, and mechanical risks.

18. The method of claim 17, wherein said individual risks are selected from a group  
consisting of: H2S and CO2, Hydrates, Well water depth, Tortuosity, Dogleg severity,  
10 Directional Drilling Index, Inclination, Horizontal displacement, Casing Wear, High pore pressure, Low pore pressure, Hard rock, Soft Rock, High temperature, Water-depth to rig rating, Well depth to rig rating, mud weight to kick, mud weight to losses, mud weight to fracture, mud weight window, Wellbore stability window, wellbore stability, Hole section length, Casing design factor, Hole to casing clearance, casing to casing clearance, casing  
15 to bit clearance, casing linear weight, Casing maximum overpull, Low top of cement, Cement to kick, cement to losses, cement to fracture, Bit excess work, Bit work, Bit footage, bit hours, Bit revolutions, Bit Rate of Penetration, Drillstring maximum overpull, Bit compressive strength, Kick tolerance, Critical flow rate, Maximum flow rate, Small nozzle area, Standpipe pressure, ECD to fracture, ECD to losses, Gains, Gains Average,  
20 Losses, Losses average, Stuck, Stuck average, Mechanical, Mechanical average, Risk Average, Subsea BOP, Large Hole, Small Hole, Number of casing strings, Drillstring parting, and Cuttings.

19. The method of claim 18, wherein the step of generating said risk information in  
25 response to said plurality of ranked risk values comprises the steps of:

receiving said plurality of ranked risk values and calculating said one or more ranked risk categories.

20. The method of claim 19, wherein the step of displaying said risk information comprises the step of: displaying said one or more ranked risk categories.

21. The method of claim 20, wherein the step of generating said risk information in response to said plurality of ranked risk values comprises the steps of:

receiving said plurality of ranked risk values and calculating said one or more ranked subcategory risks.

22. The method of claim 21, wherein the step of displaying said risk information comprises the step of: displaying said one or more ranked subcategory risks.

23. The method of claim 22, wherein the step of generating said risk information in response to said plurality of ranked risk values comprises the steps of:

receiving said plurality of ranked risk values and using said plurality of ranked risk values to represent said plurality of ranked individual risks.

24. The method of claim 23, wherein the step of displaying said risk information comprises the step of: displaying said plurality of ranked individual risks.

25. A program storage device readable by a machine tangibly embodying a program of instructions executable by the machine to perform method steps for determining and displaying risk information in response to a plurality of input data, said method steps comprising:

receiving said plurality of input data, said input data including a plurality of input data calculation results;

comparing each calculation result of said plurality of input data calculation results with each logical expression of a plurality of logical expressions, ranking by said logical expression said calculation result, and generating a plurality of ranked risk values in response thereto, each of said plurality of ranked risk values representing an input data  
5 calculation result that has been ranked by said logical expression as either a high risk or a medium risk or a low risk;

generating said risk information in response to said plurality of ranked risk values; and

10 displaying said risk information.

26. The program storage device of claim 25, wherein said risk information comprises a one or more ranked risk categories.

15 27. The program storage device of claim 25, wherein said risk information comprises one or more ranked subcategory risks.

28. The program storage device of claim 25, wherein said risk information comprises a plurality of ranked individual risks.

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29. The program storage device of claim 26, wherein said risk categories are selected from a group consisting of: an average individual risk, a subcategory risk, an average subcategory risk, a total risk, an average total risk, a potential risk for each design task, and an actual risk for each design task.

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30. The program storage device of claim 29, wherein said subcategory risks of said risk categories is selected from a group consisting of: gains risks, losses risks, stuck pipe risks, and mechanical risks.

31. The program storage device of claim 28, wherein said individual risks are selected from a group consisting of: H2S and CO2, Hydrates, Well water depth, Tortuosity, Dogleg severity, Directional Drilling Index, Inclination, Horizontal displacement, Casing Wear, High pore pressure, Low pore pressure, Hard rock, Soft Rock, High temperature,  
5 Water-depth to rig rating, Well depth to rig rating, mud weight to kick, mud weight to losses, mud weight to fracture, mud weight window, Wellbore stability window, wellbore stability, Hole section length, Casing design factor, Hole to casing clearance, casing to casing clearance, casing to bit clearance, casing linear weight, Casing maximum overpull, Low top of cement, Cement to kick, cement to losses, cement to fracture, Bit excess  
10 work, Bit work, Bit footage, bit hours, Bit revolutions, Bit Rate of Penetration, Drillstring maximum overpull, Bit compressive strength, Kick tolerance, Critical flow rate, Maximum flow rate, Small nozzle area, Standpipe pressure, ECD to fracture, ECD to losses, Gains, Gains Average, Losses, Losses average, Stuck, Stuck average, Mechanical, Mechanical average, Risk Average, Subsea BOP, Large Hole, Small Hole,  
15 Number of casing strings, Drillstring parting, and Cuttings.

32. The program storage device of claim 26, wherein the step of generating said risk information in response to said plurality of ranked risk values comprises the steps of:  
20 receiving said plurality of ranked risk values and calculating said one or more ranked risk categories.

33. The program storage device of claim 32, wherein the step of displaying said risk information comprises the step of: displaying said one or more ranked risk categories.  
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34. The program storage device of claim 27, wherein the step of generating said risk information in response to said plurality of ranked risk values comprises the steps of:  
receiving said plurality of ranked risk values and calculating said one or more ranked  
30 subcategory risks.

35. The program storage device of claim 34, wherein the step of displaying said risk information comprises the step of: displaying said one or more ranked subcategory risks.

5 36. The program storage device of claim 28, wherein the step of generating said risk information in response to said plurality of ranked risk values comprises the steps of:

receiving said plurality of ranked risk values and using said plurality of ranked risk values to represent said plurality of ranked individual risks.

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37. The program storage device of claim 36, wherein the step of displaying said risk information comprises the step of: displaying said plurality of ranked individual risks.

15 38. The program storage device of claim 26, wherein said risk information comprises one or more ranked subcategory risks.

39. The program storage device of claim 38, wherein said risk information comprises a plurality of ranked individual risks.

20 40. The program storage device of claim 39, wherein said risk categories are selected from a group consisting of: an average individual risk, a subcategory risk, an average subcategory risk, a total risk, an average total risk, a potential risk for each design task, and an actual risk for each design task.

25 41. The program storage device of claim 40, wherein said subcategory risks of said risk categories is selected from a group consisting of: gains risks, losses risks, stuck pipe risks, and mechanical risks.

30 42. The program storage device of claim 41, wherein said individual risks are selected from a group consisting of: H<sub>2</sub>S and CO<sub>2</sub>, Hydrates, Well water depth, Tortuosity,



Dogleg severity, Directional Drilling Index, Inclination, Horizontal displacement, Casing Wear, High pore pressure, Low pore pressure, Hard rock, Soft Rock, High temperature, Water-depth to rig rating, Well depth to rig rating, mud weight to kick, mud weight to losses, mud weight to fracture, mud weight window, Wellbore stability window, wellbore stability, Hole section length, Casing design factor, Hole to casing clearance, casing to casing clearance, casing to bit clearance, casing linear weight, Casing maximum overpull, Low top of cement, Cement to kick, cement to losses, cement to fracture, Bit excess work, Bit work, Bit footage, bit hours, Bit revolutions, Bit Rate of Penetration, Drillstring maximum overpull, Bit compressive strength, Kick tolerance, Critical flow rate, Maximum flow rate, Small nozzle area, Standpipe pressure, ECD to fracture, ECD to losses, Gains, Gains Average, Losses, Losses average, Stuck, Stuck average, Mechanical, Mechanical average, Risk Average, Subsea BOP, Large Hole, Small Hole, Number of casing strings, Drillstring parting, and Cuttings.

43. The program storage device of claim 44, wherein the step of generating said risk information in response to said plurality of ranked risk values comprises the steps of:

receiving said plurality of ranked risk values and calculating said one or more ranked risk categories.

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44. The program storage device of claim 43, wherein the step of displaying said risk information comprises the step of: displaying said one or more ranked risk categories.

45. The program storage device of claim 44, wherein the step of generating said risk information in response to said plurality of ranked risk values comprises the steps of:

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receiving said plurality of ranked risk values and calculating said one or more ranked subcategory risks.

46. The program storage device of claim 45, wherein the step of displaying said risk information comprises the step of: displaying said one or more ranked subcategory risks.

47. The program storage device of claim 46, wherein the step of generating said risk information in response to said plurality of ranked risk values comprises the steps of:

receiving said plurality of ranked risk values and using said plurality of ranked risk values to represent said plurality of ranked individual risks.

48. The program storage device of claim 47, wherein the step of displaying said risk information comprises the step of: displaying said plurality of ranked individual risks.

49. The method of claim 1, wherein said input data is selected from a group consisting of: Casing Point Depth, Measured Depth, True Vertical Depth, Mud Weight, Measured Depth, ROP, Pore Pressure, Static Temperature, Pump Rate, Dog Leg Severity, ECD, Inclination, Hole Size, Casing Size, Easting-westing, Northing-Southing, Water Depth, Maximum Water Depth, Maximum well Depth, Kick Tolerance, Drill Collar 1 Weight, Drill Collar 2 Weight, Drill Pipe Weight, Heavy Weight Weight, Drill Pipe Tensile Rating, Upper Wellbore Stability Limit, Lower Wellbore Stability Limit, Unconfined Compressive Strength, Bit Size, Mechanical drilling energy (UCS integrated over distance drilled by the bit), Ratio of footage drilled compared to statistical footage, Cumulative UCS, Cumulative Excess UCS, Cumulative UCS Ratio, Average UCS of rock in section, Bit Average UCS of rock in section, Statistical Bit Hours, Statistical Drilled Footage for the bit, RPM, On Bottom Hours, Calculated Total Bit Revolutions, Time to Trip, Critical Flow Rate, Maximum Flow Rate in hole section, Minimum Flow Rate in hole section, Flow Rate, Total Nozzle Flow Area of bit, Top Of Cement, Top of Tail slurry, Length of Lead slurry, Length of Tail slurry, Cement Density Of Lead, Cement Density Of Tail slurry, Casing Weight per foot, Casing Burst Pressure, Casing Collapse Pressure, Casing Type Name, Hydrostatic Pressure of Cement column, Start Depth, End Depth, Conductor, Hole Section Begin Depth, Openhole Or Cased hole

completion, Casing Internal Diameter, Casing Outer Diameter, Mud Type, Pore Pressure without Safety Margin, Tubular Burst Design Factor, Casing Collapse Pressure Design Factor, Tubular Tension Design Factor, Derrick Load Rating, Drawworks Rating, Motion Compensator Rating, Tubular Tension rating, Statistical Bit ROP, Statistical Bit RPM, Well Type, Maximum Pressure, Maximum Liner Pressure Rating, Circulating Pressure, Maximum UCS of bit, Air Gap, Casing Point Depth, Presence of H2S, Presence of CO2, Offshore Well, and Flow Rate Maximum Limit.

50. The method of claim 8, wherein the step of calculating said one or more ranked risk categories comprises the step of:

calculating an average individual risk by using the following equation.

$$\text{Average individual risk} = \frac{\sum_i^n \text{Riskvalue}_i}{n}.$$

51. The method of claim 50, wherein the step of calculating said one or more ranked risk categories comprises the further step of:

calculating a risk subcategory by using the following equation:

$$\text{Risk Subcategory} = \frac{\sum_j^n (\text{Riskvalue}_j \times \text{severity}_j \times N_j)}{\sum_j (\text{severity}_j \times N_j)}.$$

52. The method of claim 51, wherein the step of calculating said one or more ranked risk categories comprises the further step of:

calculating an average subcategory risk by using the following equation:

$$\text{Average subcategory risk} = \frac{\sum_i^n (\text{Risk Subcategory}_i \times \text{risk multiplier}_i)}{\sum_i^n \text{risk multiplier}_i}.$$

53. The method of claim 52, wherein the step of calculating said one or more ranked risk categories comprises the further step of:

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calculating a risk total by using the following equation:

$$\text{Risk Total} = \frac{\sum_k^4 \text{Risk subcategory}_k}{4}.$$

10 54. The method of claim 53, wherein the step of calculating said one or more ranked risk categories comprises the further step of:

calculating an average total risk by using the following equation:

$$15 \quad \text{Average total risk} = \frac{\sum_i^n (\text{Risk Subcategory}_i \times \text{risk multiplier}_i)}{\sum_i^n \text{risk multiplier}_i}.$$

55. The method of claim 54, wherein the step of calculating said one or more ranked risk categories comprises the further step of:

20 calculating a potential risk by using the following equation:

$$\text{Potential Risk}_k = \frac{\sum_{j=1}^{55} (90 \times \text{Severity}_{k,j} \times N_{k,j})}{\sum_{j=1}^{55} (\text{Severity}_{k,j} \times N_{k,j})}.$$

56. The method of claim 55, wherein the step of calculating said one or more ranked risk categories comprises the further step of:

calculating an actual risk by using the following equation:

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$$Actual\ Risk_k = \frac{\sum_{j=1}^{55} (Average\ Individual\ Risk_j \times Severity_{j,k} \times N_{k,j})}{\sum_{j=1}^{55} (Severity_j \times N_{k,j})}.$$

57. The program storage device of claim 32, wherein the step of calculating said one or more ranked risk categories comprises the step of:

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calculating an average individual risk by using the following equation.

$$Average\ individual\ risk = \frac{\sum_i^n Riskvalue_i}{n}.$$

15 58. The program storage device of claim 57, wherein the step of calculating said one or more ranked risk categories comprises the further step of:

calculating a risk subcategory by using the following equation:

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$$Risk\ Subcategory = \frac{\sum_j^n (Riskvalue_j \times severity_j \times N_j)}{\sum_j (severity_j \times N_j)}.$$

59. The program storage device of claim 58, wherein the step of calculating said one or more ranked risk categories comprises the further step of:

25 calculating an average subcategory risk by using the following equation:

$$\text{Average subcategory risk} = \frac{\sum_i^n (\text{Risk Subcategory}_i \times \text{risk multiplier}_i)}{\sum_i^n \text{risk multiplier}_i}.$$

60. The program storage device of claim 59, wherein the step of calculating said one or more ranked risk categories comprises the further step of:

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calculating a risk total by using the following equation:

$$\text{Risk Total} = \frac{\sum_k^4 \text{Risk subcategory}_k}{4}.$$

10 61. The program storage device of claim 60, wherein the step of calculating said one or more ranked risk categories comprises the further step of:

calculating an average total risk by using the following equation:

$$15 \quad \text{Average total risk} = \frac{\sum_i^n (\text{Risk Subcategory}_i \times \text{risk multiplier}_i)}{\sum_i^n \text{risk multiplier}_i}.$$

62. The program storage device of claim 61, wherein the step of calculating said one or more ranked risk categories comprises the further step of:

20 calculating a potential risk by using the following equation:

$$\text{Potential Risk}_k = \frac{\sum_{j=1}^{55} (90 \times \text{Severity}_{k,j} \times N_{k,j})}{\sum_{j=1}^{55} (\text{Severity}_{k,j} \times N_{k,j})}.$$

63. The program storage device of claim 62, wherein the step of calculating said one or more ranked risk categories comprises the further step of:

calculating an actual risk by using the following equation:

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$$Actual\ Risk_k = \frac{\sum_{j=1}^{55} (Average\ Individual\ Risk_j \times Severity_{j,j} \times N_{k,j})}{\sum_{j=1}^{55} (Severity_j \times N_{k,j})}.$$

64. A system adapted for determining and displaying risk information in response to a plurality of input data, comprising:

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apparatus adapted for receiving said plurality of input data, said input data including a plurality of input data calculation results;

apparatus adapted for comparing each calculation result of said plurality of input data

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calculation results with each logical expression of a plurality of logical expressions, ranking, by said logical expression, said calculation result, and generating a plurality of ranked risk values in response thereto, each of said plurality of ranked risk values representing an input data calculation result that has been ranked by said logical expression as either a high risk or a medium risk or a low risk;

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apparatus adapted for generating said risk information in response to said plurality of ranked risk values; and

apparatus adapted for displaying said risk information.

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65. The system of claim 64, wherein said risk information comprises a one or more ranked risk categories.

66. The system of claim 64, wherein said risk information comprises one or more ranked subcategory risks.

67. The system of claim 64, wherein said risk information comprises a plurality of  
5 ranked individual risks.

68. The system of claim 65, wherein said risk categories are selected from a group consisting of: an average individual risk, a subcategory risk, an average subcategory risk, a total risk, an average total risk, a potential risk for each design task, and an actual risk  
10 for each design task.

69. The system of claim 66, wherein said subcategory risks of said risk categories is selected from a group consisting of: gains risks, losses risks, stuck pipe risks, and mechanical risks.  
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70. The system of claim 67, wherein said individual risks are selected from a group consisting of: H2S and CO2, Hydrates, Well water depth, Tortuosity, Dogleg severity, Directional Drilling Index, Inclination, Horizontal displacement, Casing Wear, High pore pressure, Low pore pressure, Hard rock, Soft Rock, High temperature, Water-depth to rig rating, Well depth to rig rating, mud weight to kick, mud weight to losses, mud weight to fracture, mud weight window, Wellbore stability window, wellbore stability, Hole section length, Casing design factor, Hole to casing clearance, casing to casing clearance, casing to bit clearance, casing linear weight, Casing maximum overpull, Low top of cement, Cement to kick, cement to losses, cement to fracture, Bit excess work, Bit work, Bit  
20 footage, bit hours, Bit revolutions, Bit Rate of Penetration, Drillstring maximum overpull, Bit compressive strength, Kick tolerance, Critical flow rate, Maximum flow rate, Small nozzle area, Standpipe pressure, ECD to fracture, ECD to losses, Gains, Gains Average, Losses, Losses average, Stuck, Stuck average, Mechanical, Mechanical average, Risk Average, Subsea BOP, Large Hole, Small Hole, Number of casing strings, Drillstring  
25 parting, and Cuttings.  
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